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Toxicological Profile for

CADMIUM

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry

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TOXICOLOGICAL PROFILE FOR CADMIUM

Prepared by:

Life Systems, Inc.
Under Subcontract to:

Clement International Corporation
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Prepared for:

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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UPDATE STATEMENT

A Toxicological Profile for cadmium was released on March 1989. This edition supersedes any previously released draft or final profile.

Toxicological profiles are revised and republished as necessary, but no less than once every three years. For information regarding the update status of previously released profiles, contact ATSDR at:

Agency for Toxic Substances and Disease Registry
Division of Toxicology/Toxicology Information Branch
1600 Clifton Road NE, E-29
Atlanta, Georgia 30333

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1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about cadmium and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,300 sites on its National Priorities List (NPL). Cadmium has been found in at least 388 of these sites. However, we do not know how many of the 1,300 NPL sites have been evaluated for cadmium. As EPA evaluates more sites, the number of sites at which cadmium is found may change. This information is important for you to know because cadmium may cause harmful health effects and because these sites are potential or actual sources of human exposure to cadmium.

When a chemical is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment as a chemical emission. This emission, which is also called a release, does not always lead to exposure. You can be exposed to a chemical only when you come into contact with the chemical. You may be exposed to it in the environment by breathing, eating, or drinking substances containing the chemical or from skin contact with it.

If you are exposed to a hazardous chemical such as cadmium, several factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, sex, nutritional status, family traits, life style, and state of health.

1.1 WHAT IS CADMIUM?

Cadmium is an element that occurs naturally in the earth's crust. Pure cadmium is a soft, silver-white metal; however, cadmium is not usually found in the environment as a metal. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). These compounds are solids that may dissolve in water but do not evaporate or disappear from the environment. All soils and rocks, including coal and mineral fertilizers, have some cadmium in them. Cadmium is often found as part of small particles present in air. You cannot tell by smell or taste that cadmium is present in air or water, because it does not have any definite taste or odor.

Most cadmium used in this country is extracted during the production of other metals such as zinc, lead, or copper. Cadmium has many uses in industry and consumer products, mainly batteries, pigments, metal coatings, and plastics.

More information on the properties and uses of cadmium may be found in Chapters 3 and 4.

1.2 WHAT HAPPENS TO CADMIUM WHEN IT ENTERS THE ENVIRONMENT?

Cadmium can enter the environment in several ways. It can enter the air from the burning of coal and household waste, and metal mining and refining processes. It can enter water from disposal of waste water from households or industries. Fertilizers often have some cadmium in them and fertilizer use causes cadmium to enter the soil. Spills and leaks from hazardous waste sites can also cause cadmium to enter soil or water. Cadmium attached to small particles may get into the air and travel a long way before coming down to earth as dust or in rain or snow. Cadmium does not break down in the environment but can change into different forms. Most cadmium stays where it enters the environment for a long time. Some of the cadmium that enters water will bind to soil but some will remain in the water. Cadmium in soil can enter water or be taken up by plants. Fish, plants, and animals take up cadmium from the environment.

More information on how cadmium behaves in the environment may be found in Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO CADMIUM?

Food and cigarette smoke are the largest potential sources of cadmium exposure for members of the general population. Average cadmium levels in U.S. foods range from 2 to 40 parts of cadmium per billion parts of food (ppb) (1,000 ppb equals one part per million). Average cadmium levels in cigarettes range from 1,000 to 3,000 ppb. Air levels in U.S. cities are low, ranging from 5 to 40 nanograms per cubic meter (ng/m^3) (one million ng/m^3 equals one milligram per cubic meter). The level of cadmium in most drinking water supplies is less than 1 ppb. In the United States, the average person eats food with about 30 micrograms (μg) of cadmium in it each day. About 1–3 μg per day of cadmium is absorbed from food, and smokers absorb an additional 1–3 μg per day from cigarettes. Smoke from other people's cigarettes probably does not cause nonsmokers to take in much cadmium. Cadmium is found at hazardous waste sites at average concentrations of about 4 ppb in soil and 5 ppb in water. Workers can be exposed to cadmium in air from making cadmium products such as batteries or paints. Workers can also be exposed from working with metal by soldering or welding. Each year almost 90,000 workers are exposed to cadmium in the United States.

More information on how you might be exposed to cadmium is given in Chapter 5.

1.4 HOW CAN CADMIUM ENTER AND LEAVE MY BODY?

Cadmium can enter your body from food you eat, water you drink, or particles you breathe in. Very little cadmium enters through your skin. Your body rapidly takes in about one-quarter of the cadmium you breathe, and about one-twentieth of the cadmium you eat. The rest of the cadmium is breathed out or excreted in feces. If you do not eat foods that contain enough iron or other nutrients, you are likely to take up more cadmium from your food than usual. Cigarette smoke has cadmium in it and so smokers breathe in cadmium. Other people who breathe in cadmium are people who work with cadmium, and people who live near hazardous waste sites or factories that release cadmium into the air. The general population and people living near hazardous waste sites may eat or drink cadmium in food, dust, or water.

Cadmium that enters your body stays in your liver and kidneys. Cadmium leaves your body slowly, in urine and feces. Your body keeps most cadmium in a form that is not harmful, but too much cadmium can overload your kidneys' storage system and cause health damage.

More information on how cadmium enters and leaves the body is given in Chapter 2.

1.5 HOW CAN CADMIUM AFFECT MY HEALTH?

Cadmium has no known good effects on your health. Breathing air with very high levels of cadmium severely damages the lungs and can cause death. Breathing lower levels for years leads to a build-up of cadmium in the kidneys that can cause kidney disease. Other effects that may occur after breathing cadmium for a long time are lung damage and fragile bones. Workers who inhale cadmium for a long time may have an increased chance of getting lung cancer. No proof has been found that mice or hamsters that breathe in cadmium get lung cancer. However, some rats that breathe in cadmium do develop lung cancer. We do not know if breathing cadmium can affect your ability to have children or can harm unborn babies. Female rats and mice that breathe high levels of cadmium have fewer litters and the pups may have more birth defects than usual. Breathing cadmium causes liver damage and changes in the immune system in rats and mice. We do not know if breathing cadmium harms the liver, heart, nervous system, or immune system in humans.

Eating food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea. The only people who have died from drinking cadmium are people who used cadmium to commit suicide. Eating lower levels of cadmium over a long period of time leads to a build-up of cadmium in the kidneys. This cadmium build-up causes kidney damage, and also causes bones to become fragile and

break easily. We know that if female rats or mice eat or drink cadmium, their litters may be harmed. We do not know if eating cadmium affects your ability to have children or harms unborn babies. Animals eating or drinking cadmium sometimes get high blood pressure, iron poor blood, liver disease, and nerve or brain damage. We do not know if humans eating or drinking cadmium get any of these diseases. Studies of humans or animals that eat or drink cadmium have not found increases in cancer. These studies were not strong enough to show that eating or drinking cadmium definitely does not cause cancer. The Department of Health and Human Services has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer has determined that cadmium is probably carcinogenic to humans. The EPA has determined that cadmium is a probable human carcinogen by inhalation. Skin contact with cadmium is not known to cause health effects in humans or animals.

More information on how cadmium can affect your health is given in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CADMIUM?

You may be tested for exposure to cadmium in several ways. The amount of cadmium in your blood, urine, hair, or nails may be measured in some medical laboratories. The amount of cadmium in your blood shows your recent exposure to cadmium. The amount in your urine shows both your recent and your past exposure. It is not known how reliable cadmium levels are in hair or nails. Tests are also available to measure the amount of cadmium inside your liver or kidneys. The results of these tests can help a doctor evaluate your risk of kidney disease. However, these tests are too costly and inconvenient for routine use. Your urine can be tested to see if your kidneys are damaged. These tests do not prove that cadmium caused the kidney disease.

More information on how cadmium can be measured in exposed humans is presented in Chapters 2 and 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The government has taken steps to protect humans from excessive cadmium exposure. The EPA now allows 10 ppb of cadmium in drinking water, and plans to reduce the limit to 5 ppb. The EPA limits how much cadmium can be put into lakes, rivers, dumps, and cropland. The EPA does not allow cadmium in pesticides. The Food and Drug Administration (FDA) limits the amount of cadmium in food colors to 15 ppm.

The Occupational Safety and Health Administration (OSHA) now limits workplace air to 100 μg cadmium/m^3 as cadmium fumes and 200 μg cadmium/m^3 as cadmium dust. OSHA is planning to limit all cadmium compounds either to 1 or to 5 μg/m^3. Because breathing cadmium may cause lung cancer, the National Institute for Occupational Safety and Health (NIOSH) wants workers to breathe as little cadmium as possible.

More information on governmental rules regarding cadmium can be found in Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, E-29
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This agency can also provide you with information on the location of the nearest occupational and environmental health clinic. These clinics specialize in the recognition, evaluation, and treatment of illnesses resulting from exposure to hazardous substances.